

Chromosome numbers of 14 species in *Amaranthus* from China

^{1,2}SONG Bao-Hua ²ZHANG Xue-Jie ²LI Fa-Zeng* ³WAN Peng

¹(Laboratory of Systematic and Evolutionary Botany, Institute of Botany, the Chinese Academy of Sciences, Beijing 100093, China)

²(The Key Laboratory of Plant Stress, Shandong Normal University, Jinan, Shandong 250014, China)

³(Shandong University of Traditional Chinese Medicine, Jinan, Shandong 250014, China)

Abstract In this paper, chromosome numbers of 14 species of the genus *Amaranthus* from China are reported: *A. retroflexus* $2n = 34$, *A. caudatus* $2n = 32$, *A. hybridus* $2n = 32$, *A. spinosus* $2n = 34$, *A. cruentus* $2n = 34$, *A. hypochondriacus* $2n = 32$, *A. paniculatus* $2n = 32$, *A. roxburghianus* $2n = 34$, *A. blitoides* $2n = 32$, *A. polygonoides* $2n = 34$, *A. albus* $2n = 32$, *A. viridis* $2n = 34$, *A. lividus* $2n = 34$, *A. tricolor* $2n = 34$. The number in *A. roxburghianus* is reported here for the first time. The basic chromosome numbers in this genus are $x = 16$ and $x = 17$ and both numbers are found in sect. *Amaranthus* and sect. *Blitopsis*. The chromosomes in this genus are very small in size, hampering a detailed karyotype analysis.

Key words *Amaranthus*; Chromosome number; Basic chromosome number

The genus *Amaranthus* of the Amaranthaceae, comprising some 50 species, belongs to subtribe Amarantinae, tribe Amaranteae, subfamily Amarantioideae (Lawrence, 1951; Sammour *et al.*, 1993). This genus is widely distributed through the world's temperate and tropical regions even before man converted some of species into cosmopolitan weeds and domesticates (Sauer, 1967). This genus is best known as successful weeds, nutritious agronomic crops and vegetable greens, and even colorful inflorescences (Sauer, 1950; Grant, 1959a).

Although *Amaranthus* has been cytologically well studied in some countries (Grant, 1959a, 1959b, 1959c; Sharma & Banik, 1965; Sammour *et al.*, 1993), only four Chinese species have had chromosome counts (Ge *et al.*, 1987; Xu, 1987). In this paper, 14 species of *Amaranthus* from China, including the native and domesticated ones, were cytologically studied in order to determine their chromosome number.

1 Material and Methods

All the plants studied were collected from Jinan, Shandong (Table 1). The voucher specimens were deposited in the Herbarium of Shandong Normal University, Jinan, Shandong.

The plants were cultivated in the experimental garden of Shandong Normal University before their seeds were harvested for the cytological studies. Mature seeds were cultured at $25\text{ }^{\circ}\text{C} \sim 28\text{ }^{\circ}\text{C}$. When the root tips grew to about 1 cm in length, they were cut off and pretreated in a saturated solution of p-Dichlorobenzene at about $20\text{ }^{\circ}\text{C}$ for 2.5 ~ 3 hr before they were fixed in Carnoy I (glacial acetic acid: absolute ethanol = 1:3) at $4\text{ }^{\circ}\text{C}$ for 3 ~ 24 hr. They were then macerated in 1 mol/L hydrochloric acid (HCl) at $60\text{ }^{\circ}\text{C}$ for 6 ~ 8 min, and stained in carbol fuchsin for 30 min and

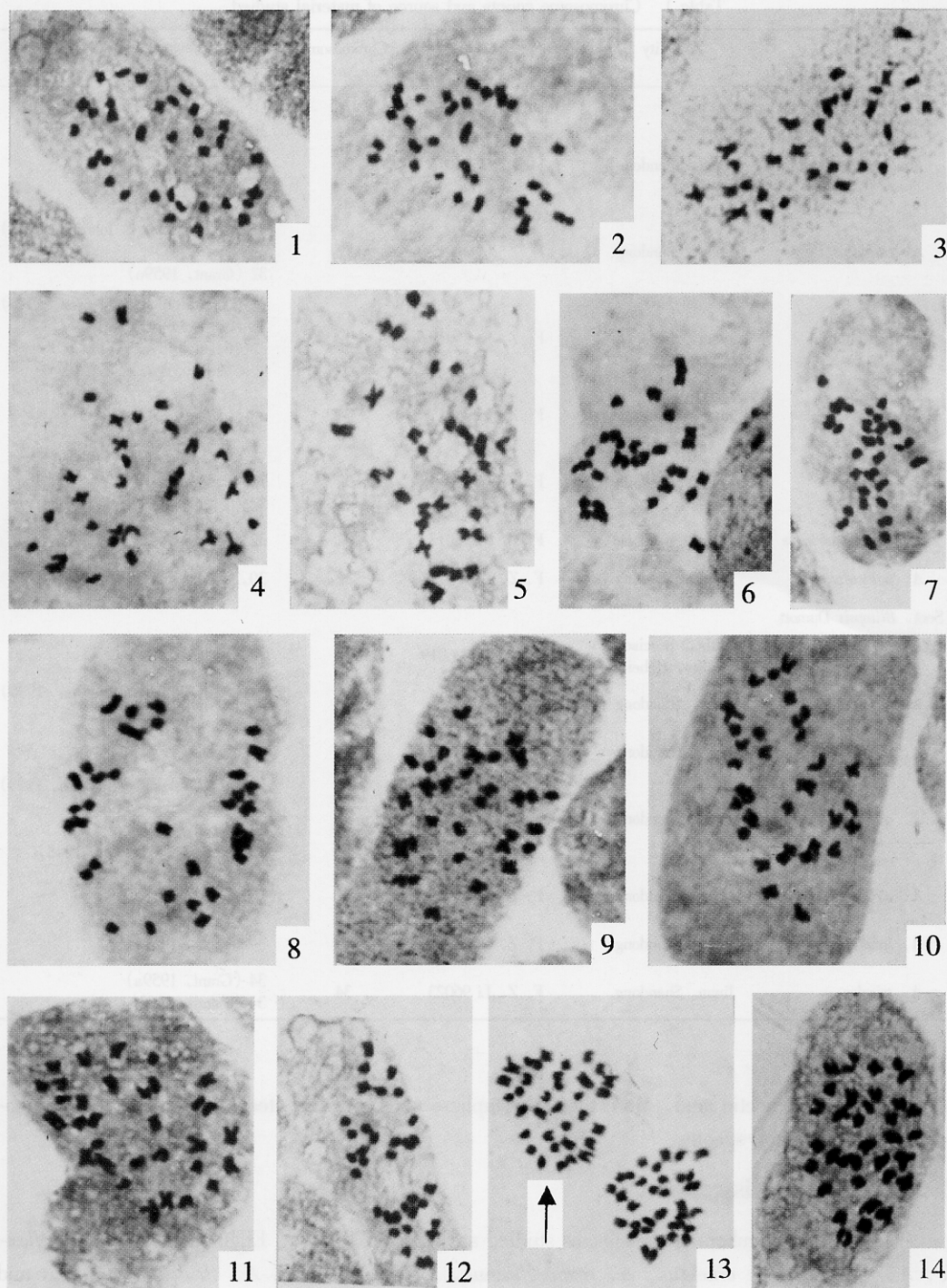
Table 1 Chromosome counts and source of material studied

Species	Locality	Voucher	Chromosome No.	Previous reports
Sect. <i>Amaranthus</i>				
<i>Amaranthus retroflexus</i>	Jinan, Shandong	F. Z. Li 96016	34	30,32,34 (Ge <i>et al.</i> , 1987) 34 (Grant, 1959c) 34 (Polya, 1949) 34 (Murray, 1940)
<i>A. caudatus</i>	Jinan, Shandong	F. Z. Li 96012	32	32 (cf. Goldblatt & Johnson, 1998) 32 (Xu, 1987) 32 (Grant, 1959c)
<i>A. hybridus</i>	Jinan, Shandong	F. Z. Li 96015	32	32 (cf. Goldblatt & Johnson, 1998) 32 (cf. Goldblatt, 1981) 32 (Grant, 1959c) 32 (Murray, 1940)
<i>A. spinosus</i>	Jinan, Shandong	F. Z. Li 96017	34	34 (Hsu, 1967) 34 (Grant, 1959b)
<i>A. cruentus</i>	Jinan, Shandong	F. Z. Li 96014	34	34 (Sammour <i>et al.</i> , 1993) 34 (Grant, 1959c) 32 (Takaji, 1933)
<i>A. hypochondriacus</i>	Jinan, Shandong	F. Z. Li 96013	32	32 (Sammour <i>et al.</i> , 1993)
<i>A. paniculatus</i>	Jinan, Shandong	F. Z. Li 96011	32	30,32,34 (Xu, 1987)
Sect. <i>Blitopsis</i> Dumort				
<i>A. roxburghianus</i>	Without precise locality, Hebei	S. J. Fan 96019	34	
<i>A. blitoides</i>	Jinan, Shandong	F. Z. Li 96021	32	32 (cf. Goldblatt & Johnson, 1998) 32 (cf. Goldblatt, 1981)
<i>A. polygonoides</i>	Jinan, Shandong	F. Z. Li 96018	34	34 (Grant, 1959c)
<i>A. albus</i>	Jinan, Shandong	F. Z. Li 96020	32	32 (cf. Goldblatt & Johnson, 1998) 32 (cf. Goldblatt, 1981) 32 (Grant, 1959c) 32 (Heiser & Whitaker, 1948)
<i>A. viridis</i>	Jinan, Shandong	F. Z. Li 96022	34	34 (Sammour <i>et al.</i> , 1993) 34 (Grant, 1959c)
<i>A. lividus</i>	Jinan, Shandong	F. Z. Li 96024	34	34 (Grant, 1959c)
<i>A. tricolor</i>	Jinan, Shandong	F. Z. Li 96023	34	34 (Grant, 1959a) 34 (Takaji, 1933)

squashed in 45% acetic acid. More than 5 metaphase cells were counted to determine the chromosome number of each species.

2 Results and discussion

Chromosome numbers of the species studied are given in Table 1. Eight species, *A. retroflexus*, *A. spinosus*, *A. cruentus*, *A. roxburghianus*, *A. polygonoides*, *A. viridis*, *A. lividus* and *A. tricolor*, have $2n = 34$, and six species, *A. caudatus*, *A. hybridus*, *A. hypochondriacus*, *A. paniculatus*, *A. blitoides* and *A. albus*, have $2n = 32$. The basic numbers of the genus *Amaranthus* should be $x = 16$ and 17.



Figs. 1~14 Photomicrographs of somatic metaphase chromosomes of 14 *Amaranthus* species from China 1. *A. retroflexus*; 2. *A. caudatus*; 3. *A. hybridus*; 4. *A. spinosus*; 5. *A. cruentus*; 6. *A. hypochondriacus*; 7. *A. paniculatus*; 8. *A. roxburghianus*; 9. *A. blitoides*; 10. *A. polygonoides*; 11. *A. albus*; 12. *A. viridis*; 13. *A. lividus* (arrow indicating the cell counted); 14. *A. tricolor*. (all $\times 2480$)

The 14 species studied fall into two sections, sect. *Amaranthus* and sect. *Blitopsis* (Pal *et al.*, 1982). It is noteworthy that in both sections the two basic chromosome numbers $x = 16$ and 17 occur in different species. Four species, *A. paniculatus*, *A. caudatus*, *A. hypochondriacus* and *A. hybridus* in sect. *Amaranthus* have $2n = 32$ while three, *A. cruentus*, *A. retroflexus* and *A. spinosus* in the same section have $2n = 34$. Similarly, *A. roxburghianus*, *A. polygonoides*, *A. viridis*, *A. lividus* and *A. tricolor* in sect. *Blitopsis* have $2n = 34$ while *A. blitoides* and *A. albus* in the same section have $2n = 32$.

Chromosomes in *Amaranthus* are mostly very small ($0.51 \mu\text{m}$ to $1.61 \mu\text{m}$) (Figs. 1 ~ 14). The small size of the chromosomes, together with their unclear centromeres, has hampered a detailed karyotype analysis.

Acknowledgements We would like to thank Dr. Kong Hong-Zhi, Laboratory of Systematic and Evolutionary Botany, Institute of Botany, the Chinese Academy of Sciences, for his comments on the paper. We also thank Professor Yang De-Kui, Shangdong Normal University, for his help during the study.

References

- Ge C-J, Li Y-K, Zhou Y *et al.*, 1987. Observations on the chromosome numbers of medicinal plants of Shangdong Province. *Acta Bot Yunnan*, 9: 333 ~ 338
- Goldblatt P, Johnson D E, 1998. Index to Plant Chromosome Numbers 1994 ~ 1995. St. Louis: Missouri Botanical Garden Press. 13
- Goldblatt P, 1981. Index to Plant Chromosome Numbers 1975 ~ 1978. St. Louis: Missouri Botanical Garden Press. 31 ~ 32
- Grant W F, 1959a. Cytogenetic studies in *Amaranthus*. I. Cytological aspects of sex determination in dioecious species. *Can J Bot*, 37: 413 ~ 417
- Grant W F, 1959b. Cytogenetic studies in *Amaranthus*. II. Natural interspecific hybridization between *Amaranthus dubius* and *A. spinosus*. *Can J Bot*, 37: 1063 ~ 1070
- Grant W F, 1959c. Cytogenetic studies in *Amaranthus*. III. Chromosome numbers and phylogenetic aspects. *Can J Genet Cytol*, 1: 313 ~ 328
- Heiser C B, Whitaker T W, 1948. Chromosome number, polyploidy, and growth habit in California weeds. *Am J Bot*, 35: 179 ~ 186
- Hsu C C, 1967. Preliminary chromosome studies on the vascular plants of Taiwan (II). *Taiwania*, 14: 11 ~ 27
- Lawrence G H M, 1951. *Taxonomy of Vascular Plants*. New York: The Macmillan Co.
- Murray M J, 1940. The genetics of sex determination in the family Amaranthaceae. *Genetics*, 25: 409 ~ 431
- Pal M, Pandey R M, Khoshoo T N, 1982. Evolution and improvement of cultivated amaranths. IX. Cytogenetic relationship between the two basic chromosome numbers. *J Hered*, 73: 353 ~ 356
- Polya L, 1949. Chromosome numbers of some Hungarian plants. I. *Acta Geob Hungar*, 6: 124 ~ 137
- Sammour R H, Hammoud M A, Abd Alla S A, 1993. Electrophoretic variations in *Amaranthus*. *Bot Bull Acad Sin*, 34: 37 ~ 42
- Sauer J D, 1950. The grain amaranths: a survey of their history and classification. *Ann MO Bot Gard*, 37: 561 ~ 619
- Sauer J D, 1967. The grain amaranths and their relatives: a revised taxonomic and geographic survey. *Ann MO Bot Gard*, 54: 103 ~ 137
- Sharma A K, Banik M, 1965. Cytological investigation of different genera of Amaranthaceae with a view to trace their relationship. *Bull Bot Soc Bengal*, 19: 40 ~ 50
- Takaji F, 1933. Über die Chromosomenzahlen bei einigen *Amaranthus*-Arten. *Bot Mag (Tokyo)*, 47: 556 ~ 557
- Xu Y-B, 1987. Studies on the chromosome number of some species of *Amaranthus*. *Grassl China*, 3: 48 ~ 50

国产十四种苋属植物的染色体数目

^{1,2}宋葆华 ²张学杰 ²李法曾 ³万鹏

¹(中国科学院植物研究所系统与进化植物学重点实验室 北京 100093)

²(山东师范大学逆境植物重点实验室 济南 250014) ³(山东中医药大学 济南 250014)

摘要 报道了国产 14 种苋属植物的染色体数目。部分种的染色体数目为 $2n = 34$, 即反枝苋 *Amaranthus retroflexus*, 刺苋 *A. spinosus*, 红苋 *A. cruentus*, 腋花苋 *A. roxburghianus*, 合被苋 *A. polygonoides*, 皱果苋 *A. viridis*, 凹头苋 *A. lividus*, 苋 *A. tricolor*。其他种的染色体数目为 $2n = 32$, 即尾穗苋 *A. caudatus*, 绿穗苋 *A. hybridus*, 千穗谷 *A. hypochondriacus*, 繁穗苋 *A. paniculatus*, 北美苋 *A. blitoides*, 白苋 *A. albus*。其中腋花苋的染色体数目为首次报道。该属染色体基数为 $x = 16, 17$ 。两种染色体基数在苋属 2 个组 (sect. *Amaranthus* 和 sect. *Blitopsis*) 中均存在。由于苋属植物染色体大多为小型染色体, 因此对苋属植物目前尚不能进行详尽的核型分析。

关键词 苋属; 染色体数目; 染色体基数